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Mechanical Damage and Losses to Crisphead Lettuce During Marketing

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ABSTRACT

Physical damage to lettuce and postharvest losses can be reduced by modifying methods of packing and closing cartons and by reducing manual handling of the packed lettuce cartons. Evaluation of three field-packing methods for lettuce showed that less moderate and serious damage occurred to lettuce when it was packed on the ground or on a "hump" (a wheelbarrow with a platform or bottom) (10.4 and 10.3 percent, respectively) than when it was packed on a hump without a bottom (25.3 percent).

Evaluation of two methods for closing the packed cartons showed that there was a smaller increase in moderate and serious damage (4.4 percent) to lettuce when the closer folded the flaps of the carton with his hand and gently placed the closing frame in position before stapling the carton closed, than when he used the closing frame and staple gun to force the carton flaps in position (8.4 percent moderate and serious damage).

Packing and closing methods that caused the greatest lettuce damage also caused the most carton damage. More than 5 percent of the cartons bulged more than 2 inches when packed on a hump without a bottom and then forced closed; whereas, less than 1 percent bulged more than 2 inches when the cartons were packed on a hump with a bottom and then were closed gently.

Loads that were mechanically placed into a highway truck had an additional 6.8 percent moderate and serious lettuce damage, compared with an additional 23.5 percent damage in hand-loaded lettuce.

Transport from Salinas, Calif., to midwestern markets increased moderate and serious lettuce damage by about 26 percent.

KEYWORDS: Lettuce damage, packing, loading, lettuce crushing, lettuce bruising, transportation, postharvest losses.

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MECHANICAL DAMAGE AND LOSSES TO CRISPHEAD LETTUCE DURING MARKETING

By R. Tom Hinsch and Roger E. Rij¹

INTRODUCTION

Western crisphead lettuce (commonly known as iceberg lettuce) accounts for approximately 20 percent of all carlots of fresh fruits and vegetables shipped from California and represents the largest volume of a single perishable commodity shipped out of State.² For efficiency, methods of handling and shipping this large and important crop should be compatible with those used for other fresh fruits and vegetables. A survey conducted by a team of USDA marketing specialists in 1973, at the request of the California Iceberg Lettuce Research Advisory Board (CILRAB), revealed that many types of fruits and vegetables were unitized at shipping point and were being delivered to wholesale, chainstore receivers on pallets.³

A later study confirmed that three-fourths of the fruit and vegetable receivers interviewed wanted their lettuce delivered on pallets.⁴

Since unitization was being practiced by many shippers of fresh fruit and vegetables, the western iceberg lettuce industry recognized the need to unitize their product. Most lettuce is naked-packed in regular-slotted, corrugated fiberboard shipping containers with inside dimensions that are 21.5 inches long, 16.124 inches wide, and 10.75 inches deep (54.6 cm by 40.95 cm by 27.3 cm). These shipping containers will be called cartons in our report.

Some shippers began to experiment with different methods of unitizing these lettuce cartons in 1975 and 1976. In 1977, one shipper began to mechanically

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²U.S. Department of Agriculture. Shipments of California fruits and vegetables. Federal-State Market News Service, U.S. Department of Agriculture, Agricultural Marketing Service, Market News Branch. 1976.

³Rij, R. E., Hinds, R. H., Hinsch, R. T., and Harris, C. M. Current practices and trends in marketing western iceberg lettuce in relation to other produce. U.S. Department of Agriculture, Marketing Research Report No. 1052, 9 p. 1976.

⁴Drossler Associates. Results of the distribution research study conducted for the California Iceberg Lettuce Advisory Board. Drossler Research Corporation, Dem-3623-01, 99 pp. 1976.

load some of his naked-packed lettuce to avoid manually loading the cartons one at a time. This lettuce, however, could not be unloaded mechanically by the receiver, so it lacked the advantage of unitization at destination.

In 1978, CILRAB funded a USDA study to determine the extent of mechanical damage to lettuce during packing, carton closing, highway truck loading, and long-distance transport.

PROCEDURES

Three different, yet similar, systems of packing lettuce were studied to determine amounts of physical damage to iceberg lettuce and to cartons. These systems were (1) packing lettuce in cartons on the ground (fig. 1), (2) packing lettuce in a carton on a "hump"⁵ with a bottom (fig. 2, A), and (3) packing lettuce in a carton on a hump without a bottom (fig. 2, B).



Figure 1.--Packing lettuce cartons in the furrow.

Lettuce damage was also evaluated after the cartons were closed. Two closing methods were observed. In one method, the person closing the cartons used a staple gun and closing frame to force the carton flaps down (fig. 3, A).

⁵A hump is a wheelbarrowlike device, with or without a full platform, on which the lettuce carton is placed while it is being packed.



Figure 2.--A, Wheelbarrow with a platform (commonly referred to as a hump). Lettuce cartons are packed on this platform instead of in the furrow.
 B, Wheelbarrow, or hump, with the bottom cut out. The lettuce is placed on the frame of the hump.



Figure 3.--A, Worker closing a carton of lettuce using the staple gun and closing frame to force the flaps down. B, Worker gently folding carton flaps before stapling carton closed.

Once the flaps were down, the closing frame was placed over the top of the carton to hold the flaps in place while they were stapled closed. In the other closing method, the closer put the staple gun and closing frame on the ground, folded the flaps by hand, placed the closing frame on top to hold down the flaps, and stapled them together (fig. 3, B).

Lettuce damage also was measured after the cartons were hand loaded into highway trucks, and after they were mechanically loaded. A final evaluation of lettuce damage was made when the cartons were unloaded by hand and transferred onto pallets at destination warehouses.

Several packing, closing, and loading crews were used to prevent bias that might occur because of individual differences in crews. More than 17,000 heads of lettuce were evaluated during this study. At least 1,400 heads were examined for mechanical damage in relation to each factor studied. Broken ribs, crushing, and bruising damage were noted. Broken ribs were scored if any of the mid-rib was broken, but torn or broken leafy tissue was not scored as broken ribs.

Crushing and bruising of the lettuce head leaves were rated in four categories as follows:

Very slight.--Torn or broken leaves, outer leaves scuffed and cell walls damaged. Seldom noticed by consumers and of no economic importance. Very slight damage is not reported here because of its seeming insignificance to shippers and consumers.

Slight.--Torn or broken leaves. Scuffed and bruised cap leaf and head leaves. Heads do not need to be trimmed before retail sale, but damage is noticeable to consumers (fig. 4).

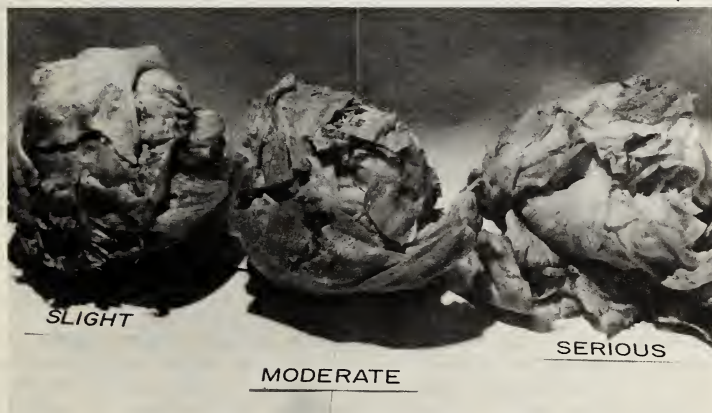


Figure 4.--Lettuce heads showing slight, moderate, and serious crushing and bruising damage. Note the progressively increasing amount of torn and broken tissue.

Moderate.--Crushed or bruised head leaves of economic importance. Heads must be trimmed before offering them for retail display. Heads damaged to this degree would affect purchase by most consumers.

Serious.--Crushed or bruised head of such magnitude that damage would be unacceptable to consumers. The head may be salvable for shredding, or offered at a distressed price to the consumer.

Physical damage to the lettuce was evaluated at four places in the handling system: (1) After packing in the field and before the carton was closed; (2) after the carton was closed and windrowed, but before it was loaded on a field truck or trailer; (3) after it was loaded in the highway truck in Salinas, Calif., for shipment to the chainstore warehouse or wholesale receiver; and (4) on arrival at an eastern or midwestern market when the cartons were unloaded onto the receiver's pallets and placed on the dock.

Carton damage was evaluated for compression or bulge for each of the three packing methods after the lettuce was packed and the carton was closed in the field. About 6,000 cartons were evaluated for damage (at least 1,500 cartons for each method), which was rated as none, less than 1 inch, 1 to 2 inches, and more than 2 inches. The number of torn cartons also was recorded.

DESCRIPTION OF PACKING AND SHIPPING SYSTEMS

Field Packing on the Ground

Most western lettuce growers and shippers pack lettuce on the ground or in the furrow. The number of cutters, packers, and closers may vary, but there are usually two lettuce cutters for each lettuce packer, forming a trio. Each cutter walks between two beds of lettuce, feels those heads on each side of the furrow that appear mature, and cuts the mature lettuce in the two beds (two rows of lettuce are planted in each bed).

The cutter places all lettuce that is cut, butt side up, on the beds. The packers follow the cutters down every fourth furrow, pick up the cut lettuce heads, and pack three heads at a time into the carton. Most cartons are packed 12 heads to a layer, two layers deep, providing a count of 24 heads per carton (a few cartons are packed with either 18 or 30 heads of lettuce, depending on the size of the heads.)

Field Packing on a Hump

Field packing on a hump varies little from ground packing except that the lettuce carton is packed on a small wheelbarrowlike device with a platform equal to the size of the bottom of the lettuce carton. The purpose of the hump is to slow down the packing rate so a premium pack can be obtained. In addition to slowing the packing rate, the hump keeps the bottom of the carton flat and prevents the bulge that occurs when cartons are packed in the furrow. Some shippers, however, remove most of the platform from their humps to make them lighter, which also allows the bottom to bulge.

Closing and Cooling

Usually, one person with a staple gun and a closing frame closes the cartons for two packers. Since many of the lettuce cartons are packed beyond their intended capacity, the closers frequently use their heavy closing frames and staple guns to force the flaps of the cartons together so they can be stapled closed.

After closing, the cartons are either left in the furrow in which they were packed or are placed in windrows for later loading when a field truck is brought in. As the truck moves slowly through the field, one person on each side of the truck picks up the cartons packed by two packers (total of four packers) and loads them on 48- by 48-inch (121.9 by 121.9 cm) pallets on the bed of the truck (fig. 5). The cartons are stacked on their sides, eight cartons per layer, and four layers high on a pallet. Each field truck carries 10 pallets for a total load of 320 cartons. The load is then tied down with "Vee" boards and straps, and taken to the vacuum cooler where a large forklift truck removes all 10 pallets at once from the field truck and sets the lettuce near the vacuum tube to await cooling.



Figure 5.--Loading lettuce cartons on a field truck. Notice that the cartons are thrown from the ground, not placed on the pallet.

Hand Loading in Highway Trailers

After cooling, the lettuce is removed from the pallets, one box at a time, and put on a conveyor belt that carries it into the refrigerated highway trailer where each carton is hand stacked in the load for shipment to market.

Mechanical Loading in Highway Trailers

For mechanical loading in refrigerated trucks, the lettuce was handled differently from the time the field trucks were loaded. The field trucks were equipped with two special racks (fig. 6 A, B), each of which had two metal "take it or leave it" pallets that measured 84 by 48 inches (213.4 cm by 121.8 cm). These pallets were stacked with two layers of cartons on sides, seven wide, and five layers of cartons on bottom, five wide. Each pallet held 78 cartons of lettuce.

After the lettuce was vacuum cooled, it was assembled on a loading dock where a special forklift truck picked up all 78 cartons at one time and moved them into the highway truck (fig. 7). A push plate on the forklift truck then pushed the 78 cartons off the forks and onto the floor of the highway truck. These cartons, therefore, were never manually handled during the loading process.

RESULTS

Lettuce Damage After Packing but Before Closing

Physical damage to lettuce may occur during the selecting, cutting, or packing procedure. Significantly more damage (25.3 percent of the heads moderately and seriously damaged) occurred to lettuce when it was packed on a hump with the bottom cut out than when packed on a hump with the bottom left in (10.3 percent). Lettuce packed on the hump with the full platform had about the same amount of moderate and serious damage as that in cartons that were packed on the ground (10.4 percent) (table 1).

Lettuce Damage After Closing

When the cartons were closed by folding over the flaps by hand, placing the closing frame over the flaps to hold them in position, and stapling the carton closed, the incidence of moderately or seriously damaged lettuce heads increased 4.4 percent compared with damage that had occurred before the cartons were closed (table 2).

When the closer used the closing frame and the staple gun to force the flaps down over the packed lettuce, moderately or seriously damaged lettuce increased 8.4 percent over that evaluated before the cartons were closed. Even though cartons that were gently closed had more lettuce than those that were forced closed (56.6 vs. 53.0 pounds), the former sustained only about one-half as much moderate and serious crushing and bruising as the latter. Lettuce in the heavier cartons did, however, sustain a greater amount of broken ribs.

Carton Damage After Closing

The packing and closing methods that resulted in the most lettuce damage also resulted in the most carton damage. The most carton damage--usually bulging and tearing--occurred to those cartons that were packed on a hump without a bottom and that were forcibly closed (table 3) (fig. 8); 5 percent of these cartons bulged more than 2 inches.



Figure 6.--A, B, Field trucks for lettuce with specially mounted racks for holding cartons. Each rack is on a turntable.

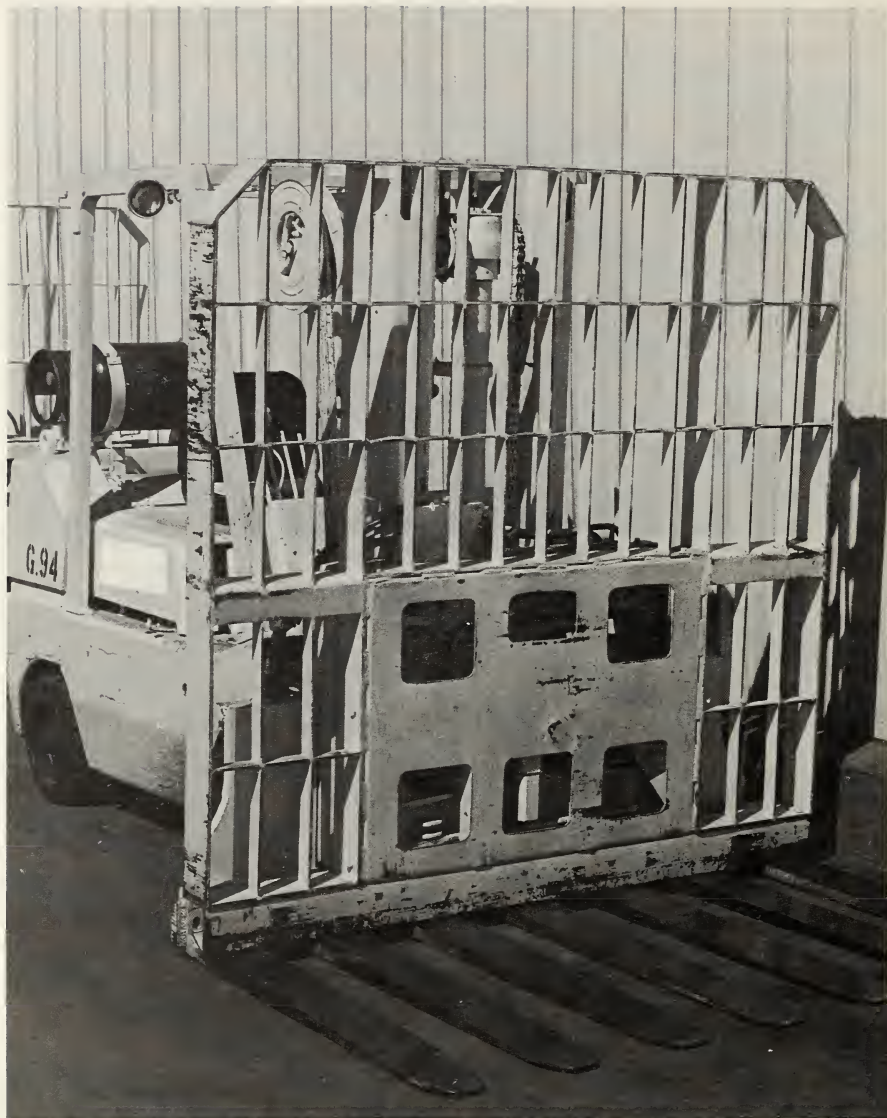


Figure 7.--Forklift truck used for loading refrigerated highway trailer with 78 cartons of lettuce at one time.

Table 1.--Percentage of slight, moderate, and serious mechanical damage occurring to lettuce during packing, by type of operation, Salinas, Calif., 1978

Packing method	Severity of damage ¹				Broken ribs
	Net weight	Slight	Moderate	Serious	
	<i>Pounds</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
On hump without bottom	53.5	² 39.7a	22.2a	3.1a	74.2a
On hump with bottom	56.6	38.4a	9.9b	.4b	77.1a
Ground pack	53.7	36.6a	9.4b	1.0ab	74.0a

¹Slight: Torn or broken leaves. Scuffed and bruised cap leaf and head leaves. Heads do not need to be trimmed before retail sale, but damage is noticeable to consumers.

Moderate: Crushed or bruised head leaves of economic importance. Heads must be trimmed before offering them for retail display. Heads damaged to this degree would affect purchase by most consumers.

Serious: Crushed or bruised head of such magnitude that damage would be unacceptable to consumers. The head may be salvable for shredding, or offered at a distressed price to the consumer.

²Means within each factor not followed by the same letter are significantly different at the 5-percent level by Duncan's multiple range test.

Table 2.--Percentage of slight, moderate, and serious mechanical damage occurring to lettuce during carton closing, by type of operation, Salinas, Calif., 1978

Closing operation	Net weight	Severity of damage ¹			Broken ribs
		Slight	Moderate	Serious	
	<i>Pounds</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>
Gently closing the carton	56.6	² 5.3a	3.7a	0.7a	8.8a
Forcing the carton closed	53.0	3.2a	7.1b	1.3b	6.6a

¹Slight: Torn or broken leaves. Scuffed and bruised cap leaf and head leaves. Heads do not need to be trimmed before retail sale, but damage is noticeable to consumers.

Moderate: Crushed or bruised head leaves of economic importance. Heads must be trimmed before offering them for retail display. Heads damaged to this degree would affect purchase by most consumers.

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²Means within each factor not followed by the same letter are statistically significant at the 5-percent level by Duncan's multiple range test.



Figure 8.--Lettuce carton bulged more than 2 inches. The overpacking has caused the carton manufacturer's joint to fail.

Table 3.--Incidence of bulged and torn lettuce carton after field packing by various methods, Salinas, Calif., 1978

Packing method	Net weight	Less than		More than	Torn
		1 inch	1-2 inches	2 inches	
	Pounds	Percent	Percent	Percent	Percent
On hump without bottom, forcing the carton closed ¹	52.3	38.2	12.1	5.5	5.7
On hump with bottom gently closed ¹	56.6	47.6	4.0	.4	.6
Ground pack, forcing the carton closed ²	53.5	52.4	5.7	.2	.3

¹Methods 1 and 2 were windrowed before carton bulge observations were made.

²Method 3 cartons were not windrowed but were left in the furrow after packing.

Damage to cartons that were packed on a hump with a bottom or on the ground was less than 1 percent (bulged more than 2 inches). Packing cartons without any support usually results in a bulged carton. The cartons packed on the ground and forced closed had a tendency to bulge, although it was not as great as it was for those cartons packed on a hump without any support for the bottom of the carton (fig. 9).



Figure 9.--These cartons were packed on the ground and had very little carton damage.

Lettuce Damage After Loading in Highway Trailer

Lettuce that was hand loaded sustained considerably more crushing and bruising damage than lettuce that was mechanically loaded in highway trailers (table 4). Almost five times more ribs were broken during the hand loading than during the machine loading.

Lettuce that was hand loaded in highway trailers also received an additional handling when it was taken off the field pallets and set on the conveyer belt that takes it to the truck loading area. Consequently, each carton of hand-loaded lettuce received two more handlings than lettuce cartons that were mechanically loaded.

Evaluation of physical damage to lettuce after it was loaded into the highway trucks showed that no more damage occurred to lettuce in the lower layers of the load than in the middle or upper layers of the load, irrespective of the loading method (fig. 10). The figures shown are indexed to show the variation from 100, by layer. The variations in the amount of lettuce damage shown in figure 10 cannot be explained except that they occurred by chance. The differences were not statistically significant.

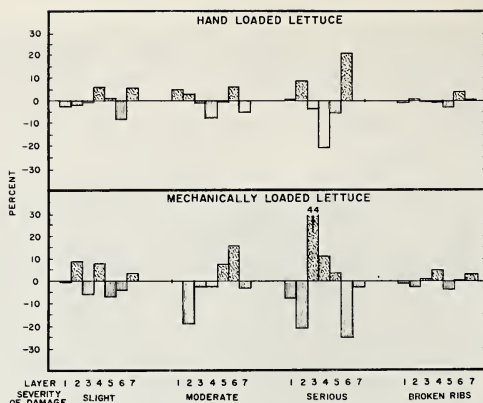


Figure 10.--Incidence of slight, moderate, and serious mechanical damage and of broken ribs in lettuce after being loaded in a highway trailer but before transit. Layer 1 is the top layer, and layer 7 is the bottom layer in the load. Data are expressed as deviations from the mean percentage of heads damaged, by loading method, and layer in the load, Salinas, Calif., 1978.

Table 4.--Effect of loading method on percentage of slight, moderate, and serious mechanical damage to lettuce, Salinas, Calif., 1978

Loading operation	Net weight	Severity of damage ¹			Broken ribs
		Slight	Moderate	Serious	
	Pounds	Percent	Percent	Percent	Percent
Hand loaded	53.0	29.0a	18.3a	5.2a	9.4a
Mechanically loaded	55.0	4.8a	5.3b	1.5a	2.6a

¹Slight: Torn or broken leaves. Scuffed and bruised cap leaf and head leaves. Heads do not need to be trimmed before retail sale, but damage is noticeable to consumers.

Moderate: Crushed or bruised head leaves of economic importance. Heads must be trimmed before offering them for retail display. Heads damaged to this degree would affect purchase by most consumers.

Serious: Crushed or bruised head of such magnitude that damage would be unacceptable to consumers. The head may be salvable for shredding, or offered at a distressed price to the consumer.

²Means within each factor not followed by the same letter are significantly different at the 5-percent level by Duncan's multiple range test.

Lettuce Damage on Arrival at Terminal Markets

The last point in the marketing system that lettuce was evaluated was at midwestern terminal markets after it had been unloaded from the refrigerated trucks and placed on warehouse pallets (fig. 11). Moderate and serious damage increased almost 26 percent, and the number of broken ribs increased almost 12 percent above that observed at the time the lettuce was loaded in Salinas.



Figure 11.--Lettuce cartons at a midwestern market after unloading.
Note the damaged cartons.

Severity of lettuce damage was as follows:¹

	Percent
Slight	(²)
Moderate	20.9
Serious	5.0
Broken ribs	11.8

¹For definition of severity of damage, see table 4.

²The amount of slight damage declined.

The decrease in slight lettuce damage was probably a result of lettuce heads that were slightly damaged at an earlier stage in the marketing system, which became either moderately or seriously damaged as the lettuce was transported and handled again. The only data presented here are for lettuce transported by truck. No comparisons were made between different transportation methods.

DISCUSSION

Much mechanical damage to lettuce can be avoided by good management of packing and handling techniques. While the purpose of a hump, for example, is to produce a superior pack, a hump with the bottom cut out caused more damage to the lettuce than packing lettuce directly on the ground. Also, carefully packing the carton on a hump with a bottom resulted in about the same amount of mechanical damage to the lettuce as packing on the ground, despite the fact that about 3 pounds more lettuce was packed in the carton on the hump.

Closing the carton results in additional damage to the lettuce, no matter how gently it is closed. Careful closing, however, greatly reduces this damage.

Considerable moderate to serious damage occurs to lettuce from the time that it is packed and closed until it is loaded on the highway trailer. Each carton may be handled several times in the system. Almost as much damage is done to the lettuce during shipping and handling as occurs during hand loading and during the packing and closing operations. Mechanical loading of lettuce greatly reduces the amount of physical damage.

Reducing the number of handlings that lettuce must go through on its way from the grower to the consumer could result in less physical damage. Many seriously damaged lettuce heads are discarded after they are unpacked from the carton at the retail store. This discarded lettuce not only reduces the available supply to consumers, which raises the price, but the cost of the discarded heads is then added to the cost of marketable heads. The benefits from research on handling problems could be expected to yield results that are beneficial to lettuce growers and consumers.

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